WHAT IS CLAIMED IS:

1. An apparatus for converting hydrocarbon fuel into a hydrogen rich gas, comprising a plurality of modules stacked end-to-end along a common axis, wherein each module of the plurality of modules includes:
   a shell having an interior space defining a passageway for the flow of a gas stream from a first end of the shell to a second end of the shell opposite the first end, and
   a processing core being contained within the interior space for effecting a chemical, thermal, or physical change to the gas stream passing axially therethrough.

2. The apparatus as described in claim 1, wherein the plurality of modules are cylindrical in shape.

3. The apparatus as described in claim 1, wherein each module of the plurality of modules includes an annular lip at either the first end or the second end of the shell and an annular recessed portion at the opposite end of the shell, and wherein the annular lip of one module is receivable into the annular recess of the adjacent module.

4. The apparatus as described in claim 1, wherein at least one module of the plurality of modules includes an annular layer of thermally insulative material disposed between the shell and the respective processing core.

5. The apparatus as described in claim 1, wherein at least one module of the plurality of modules includes a porous support member mounted in proximity to the first end of the shell.

6. The apparatus as described in claim 1, wherein at least one module of the plurality of modules includes a porous support member mounted in proximity to the second end of the shell.

7. The apparatus as described in claim 6, wherein the porous support member is selected from the group consisting of a screen, mesh, perforated plate, and porous sintered plate.

8. The apparatus as described in claim 1, wherein the plurality of modules includes a first module, wherein the processing core of the first module includes a partial oxidation catalyst.

9. The apparatus as described in claim 8, wherein the first module also includes a steam reforming catalyst.

10. The apparatus as described in claim 8, wherein the partial oxidation catalyst includes a metal selected from the group consisting of platinum, palladium, rhodium, ruthenium, nickel, cobalt, and any combinations thereof.

11. The apparatus as described in claim 9, wherein the steam reforming catalyst includes a metal selected from the group consisting of platinum, palladium, rhodium, ruthenium, iridium, nickel, potassium, and combinations thereof.

12. The apparatus as described in claim 10, wherein the metal of the partial oxidation catalyst is supported on a material selected from the group consisting of magnesia, alumina, titania, zirconia, and silica.

13. The apparatus as described in claim 11, wherein the metal of the steam reforming catalyst is supported on a material selected from the group consisting of magnesia, alumina, silica, zirconia, and magnesium aluminate.

14. The apparatus as described in claim 1, wherein the plurality of modules includes a second module, wherein the processing core of the second module includes a first heat exchanger for cooling the gas stream.

15. The apparatus as described in claim 1, wherein the plurality of modules includes a third module, wherein the processing core of the third module includes a desulfurization agent.

16. The apparatus as described in claim 14, wherein the desulfurization agent includes zinc oxide.

17. The apparatus as described in claim 1, wherein the plurality of modules includes a fourth module, wherein the processing core of the fourth module includes an inert material for mixing components of the gas stream passing therethrough.

18. The apparatus as described in claim 17, wherein the inert material comprises ceramic beads.

19. The apparatus as described in claim 17, wherein the fourth module is designed to introduce water to the gas stream.

20. The apparatus as described in claim 1, wherein the plurality of modules includes a fifth module, wherein the processing core of the fifth module includes:
a water gas shift catalyst bed; and
a heat exchanger positioned within the water gas shift catalyst bed for maintaining a desired shift reaction temperature range.

21. The apparatus as described in claim 20, wherein the water gas shift catalyst is a low temperature water gas shift catalyst.

22. The apparatus as described in claim 21 wherein the low temperature water gas shift catalyst includes a material selected from the group consisting of copper, copper oxide, zinc, platinum, rhenium, palladium, rhodium, and gold.

23. The apparatus as described in claim 20, wherein the water gas shift catalyst is a high temperature water gas shift catalyst.

24. The apparatus as described in claim 23, wherein the high temperature water gas shift catalyst includes a material selected from the group consisting of ferric oxide, chromic oxide, copper, iron silicide, platinum, and palladium.

25. The apparatus as described in claim 1, wherein the plurality of modules includes a sixth module, wherein the processing core of the sixth module includes a second heat exchanger for cooling the gas stream.

26. The apparatus as described in claim 1, wherein the plurality of modules includes a seventh module, wherein the processing core of the seventh module includes:

a carbon monoxide oxidation catalyst bed; and

a heat exchanger positioned within the carbon monoxide oxidation catalyst bed for maintaining a desired oxidation reaction temperature range.

27. The apparatus as described in claim 26, wherein the seventh module is designed to introduce an oxygen-containing stream to the gas stream prior to contact with the carbon monoxide oxidation bed.

28. The apparatus as described in claim 26, wherein the carbon monoxide oxidation catalyst bed includes a material selected from the group consisting of platinum, palladium, iron, chromium, manganese, iron oxide, chromium oxide, manganese oxide, ruthenium, palladium, gold, and any combinations thereof.

29. An apparatus for converting hydrocarbon fuel into a hydrogen rich gas, comprising a plurality of modules stacked end-to-end along a common axis;

wherein each module of the plurality of modules includes:

a shell having an interior space defining a passageway for the flow of a gas stream from a first end of the shell to a second end of the shell opposite the first end, and

a processing core being contained within the interior space for effecting a chemical, thermal, or physical change to the gas stream passing axially therethrough; and

wherein the plurality of modules includes:

a first module containing a partial oxidation catalyst bed,

a second module positioned adjacent to the first module containing a first heat exchanger for cooling the gas stream,

a third module positioned adjacent to the second module containing a desulfurization agent,

a fourth module positioned adjacent the third module containing an inert material for mixing components of the gas stream passing therethrough,

a fifth module positioned adjacent to the fourth module containing a water gas shift catalyst bed,

a sixth module positioned adjacent to the fifth module containing a second heat exchanger for cooling the gas stream, and

a seventh module positioned adjacent to the sixth module containing a carbon monoxide oxidation catalyst bed.

30. An apparatus for converting hydrocarbon fuel into a hydrogen rich gas, comprising a plurality of modules stacked end-to-end along a common axis;

wherein each module of the plurality of modules includes:

a shell having an interior space defining a passageway for the flow of a gas stream from a first end of the shell to a second end of the shell opposite the first end, and

a processing core being contained within the interior space for effecting a chemical, thermal, or physical change to the gas stream passing axially therethrough; and

wherein the plurality of modules includes:

a first module containing a partial oxidation catalyst bed,

a second module positioned adjacent to the first module containing a first heat exchanger for cooling the gas stream,

a third module positioned adjacent to the second module containing a desulfurization agent,

a fourth module positioned adjacent to the third module containing a water gas shift catalyst bed,

a fifth module positioned adjacent to the fourth module containing a second heat exchanger for cooling the gas stream, and

a sixth module positioned adjacent to the fifth module containing a carbon monoxide oxidation catalyst bed.

31. A process for converting hydrocarbon fuel into a hydrogen rich gas comprising:

providing a fuel processor having a plurality of modules stacked end-to-end along a common axis; and

feeding the hydrocarbon fuel successively through each of the modules in an axial direction to produce the hydrogen rich gas.

32. The process as described in claim 31, wherein the plurality of modules includes:

a first module for the partial oxidation and steam reforming of the hydrocarbon fuel to produce a first module effluent;

a second module positioned adjacent to the first module for cooling the first module effluent to produce a second module effluent;

a third module positioned adjacent to the second module, wherein the third module desulfurizes the second module effluent to produce a third module effluent;

a fourth module positioned adjacent the third module, wherein the fourth module mixes water with the third module effluent to produce a fourth module effluent;

a fifth module positioned adjacent to the fourth module, wherein the fifth module reacts the water and the carbon monoxide contained in the fourth module effluent to produce a fifth module effluent having a reduced carbon monoxide concentration;

a sixth module positioned adjacent to the fifth module for cooling the fifth module effluent to produce a sixth module effluent;

a seventh module positioned adjacent to the sixth module for oxidizing at least some carbon monoxide to produce the hydrogen rich gas.

33. The process as described in claims 32, wherein the hydrocarbon fuel may be preheated by the second module, the fifth module, the sixth module, the seventh module, or any combination thereof.

34. The process as described in claims 32, wherein the first module operates at a temperature ranging from about 550°C to about 900°C.

35. The process as described in claim 32, wherein the second module effluent is from about 200°C to about 600°C.

36. The process as described in claim 32, wherein the fifth module operates at a temperature ranging from about 150°C to about 400°C.

37. The process as described in claim 32, wherein the fifth module effluent is cooled to a temperature of from about 90°C to about 150°C.

38. The process as described in claim 32, wherein the seventh module operates at a temperature of from about 90°C to about 150°C.

The process as described in claim 32, wherein the hydrogen rich gas contains less than 50 ppm carbon monoxide.

39. The process as described in claim 31, wherein the plurality of modules includes:

a first module for the partial oxidation and steam reforming of the hydrocarbon fuel to produce a first module effluent;

a second module positioned adjacent to the first module for cooling the first module effluent to produce a second module effluent;

a third module positioned adjacent to the second module, wherein the third module desulfurizes the second module effluent to produce a third module effluent;

a fourth module positioned adjacent to the third module, wherein the fourth module reacts water and the carbon monoxide contained in the third module effluent to produce a fourth module effluent having a reduced carbon monoxide concentration;

a fifth module positioned adjacent to the fourth module for cooling the fourth module effluent to produce a fifth module effluent;

a sixth module positioned adjacent to the fifth module for oxidizing at least some carbon monoxide to produce the hydrogen rich gas.

40. The process as described in claims 39, wherein the hydrocarbon fuel may be preheated by the second module, the fourth module, the fifth module, the sixth module, or any combination thereof.

41. The process as described in claims 39, wherein the first module operates at a temperature ranging from about 550°C to about 900°C.

42. The process as described in claim 39, wherein the second module effluent is from about 200°C to about 600°C.

43. The process as described in claim 39, wherein the fourth module operates at a temperature ranging from about 150°C to about 400°C.

44. The process as described in claim 39, wherein the fourth module effluent is cooled to a temperature of from about 90°C to about 150°C.

45. The process as described in claim 39, wherein the sixth module operates at a temperature of from about 90°C to about 150°C.

46. The process as described in claim 39, wherein the hydrogen rich gas contains less than 50 ppm carbon monoxide.